Nov. 3, 1936. W. C. CRIMMINS 2,059,681

FUSE

Filed Feb. 9, 1935

FIG. 1.

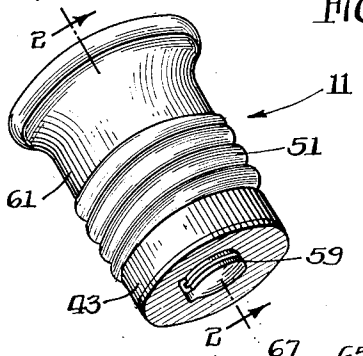
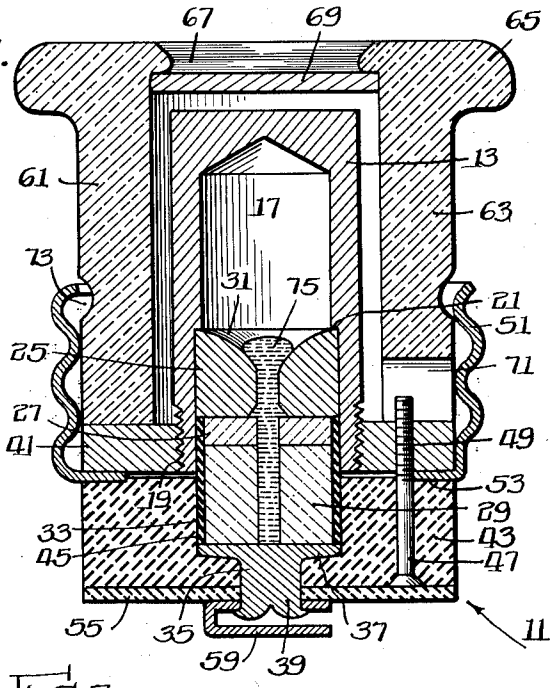


FIG. 2.



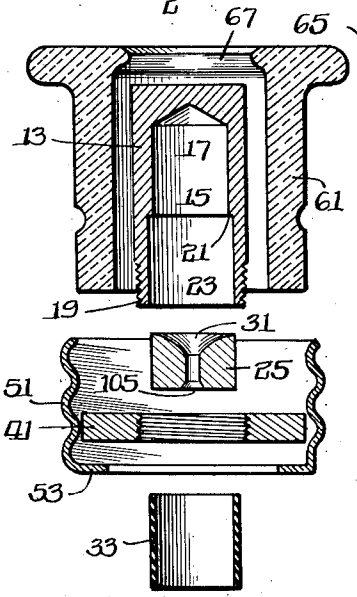


FIG. 3.

FIG. 4.

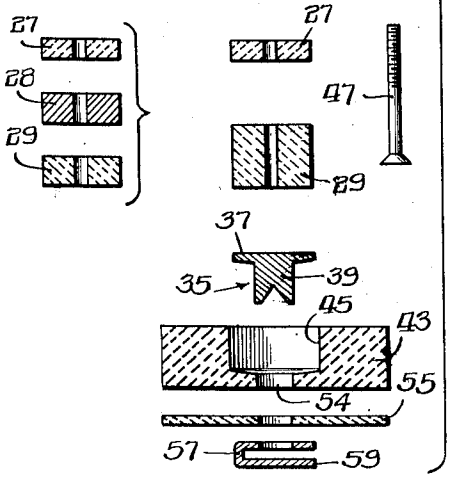
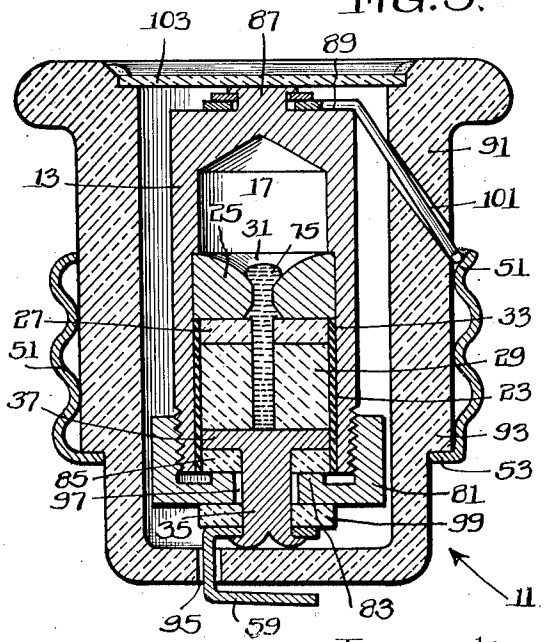


FIG. 5.



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2,059,681

UNITED STATES PATENT OFFICE

2,059,681

FUSE

William C. Crimmins, Chicago, Ill.

Application February 9, 1935, Serial No. 5,771

8 Claims. (Cl. 200—113)

My invention relates in general to protective devices for electric circuits, and has more particular reference to cut-out devices or circuit breakers for interrupting an electric circuit when the same becomes overloaded.

An important object of the invention is to provide a breaker or cut-out of the character employing a liquid current carrying medium in circuit making position and adapted for expulsion from normal current carrying position to interrupt and open the protected circuit when overload conditions prevail, the invention further providing for the return or replacement of the liquid conducting medium to current carrying position in order to render the device again effective for further use in the circuit.

Another important object is to simplify the construction of cut-out devices employing a liquid current carrying medium in order to reduce manufacturing costs and, at the same time, preventing the escape of the liquid medium from the device over long periods of service.

Another important object is to provide for confining arcing which develops upon interruption of the circuit, entirely within an arc resisting channel formed in the device.

Another important object resides in providing a channel of reduced section, in which the liquid conductor is arranged when the same is in circuit making position, and in affording a low resistance current path in parallel electrical relationship with respect to the liquid medium when the same is arranged in said channel, in order that the effective area of the current conducting path when the liquid is in position, may be relatively large so that the device may have the capacity to carry relatively large quantities of current without causing expulsion of the liquid medium.

Another important object resides in forming at least a portion of the walls of the restricted channel of an electrical conducting medium in order to increase the effective area of the conducting path at such places, and thus permit a relatively larger current to flow through the breaker without expelling the liquid medium from current carrying position than would be possible if all of the current passing the breaker is forced to travel entirely in the liquid medium in the restricted channel.

Another important object is to make at least a portion of the walls defining said channel of heat conducting material in order to rapidly dissipate the heat developed in the liquid medium in the channel during current flow therethrough in order thus to permit relatively more current to flow through the liquid medium in said channel without expelling the same from current carrying position than would be possible if said wall were formed of heat insulating material.

Another important object is to form said channel by stacking perforated plates or disks with the perforations thereof in alinement.

Another important object is to form at least some of the disks of said stack of electrical conducting material.

Another object is to form at least some of the disks of said stack of heating conducting material.

Another important object resides in forming at least some of the disks of heat and electrical conducting material such as metal.

Another important object is to provide a fuse or cut-out of the character mentioned wherein the liquid current carrying medium is at all times sealed within an explosion proof container.

Another important object is to provide an article of the class described wherein the parts are formed to facilitate assembly in a rapid, inexpensive manner.

Numerous other objects, advantages, and inherent functions of the invention will be apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawing, discloses preferred forms embodying my invention.

Referring to the drawing—

Figure 1 is a perspective view of a fuse or cut-out device embodying my present invention;

Figure 2 is a sectional view taken substantially along the line 2—2 in Figure 1;

Figure 3 is an exploded view showing the individual parts of the fuse;

Figure 4 is a view showing parts which may be substituted for certain of the fuse parts shown in Figure 3 in building a modified form of the fuse; and

Figure 5 is a sectional view similar to Figure 2 and shows a modified fuse construction embodying the invention.

To illustrate my invention I have shown on the drawing a circuit protector comprising a blow-out fuse 11, and, although the invention is not necessarily restricted to any particular type of fuse, I have shown the so-called "plug" form of the character adapted for use in receptacle sockets forming the usual power outlet in commercial circuits.

The present invention contemplates the arrangement of a liquid current conducting medi-

um, such as mercury, in a restricted channel or duct, the mercury, when so arranged in said duct, being in position to carry electrical current flowing in the circuit protected by the fuse. When the current becomes too large, the heat developed in the mercury column will vaporize the mercury and cause he same to be expelled from the restricted duct into a preferably larger channel positioned opposite an end of the duct to receive the expelled current carrying medium. It will be apparent that the amount of current which the mercury column may carry before reaching a temperature at which the medium is expelled and the circuit broken, will depend upon the current density in the column and also upon the rate at which the generated heat is abstracted from the column. It is desirable, of course, to form the restricted channel of arc resisting material. Arc resisting materials are usually non-conductors of heat and electricity. Consequently where the restricted channel is defined by ordinary arc-resisting materials, substantially all of the heat developed in the mercury column is retained therein, and substantially all of the current flowing through the protective device is confined in the liquid conducting medium. Under such conditions, I have found that, in order to provide a heavy duty fuse—for example, a fuse having the capacity to carry thirty amperes without interruption—requires a mercury column of substantial diameter in order that the current density flowing in said column be not sufficiently great to cause expulsion of the medium. It is desirable, however, to maintain the diameter of the liquid column within certain limits in order, first, to utilize surface tension of the liquid medium to retain itself in the channel against mechanical forces tending to eject the liquid, and also to keep the overall size of the device within practical limits, particularly where the fuse is embodied in the so-called "plug" type. For this reason, I propose to form the restricted channel, in which the liquid conducting medium is disposed when in circuit-making position, at least partially of a material capable of conducting the heat generated in the liquid, as a result of current flow therethrough, away from the liquid column in order to maintain the same below temperatures causing expulsion thereof, even when the current is large.

The heat-conducting portion of the restricted channel-forming means is preferably of metal and forms a conducting path in parallel with the path provided by the liquid contained in the channel to thus reduce the current density in said liquid and thus increase the capacity of the device, enabling me to produce a relatively heavy duty fuse in small compass.

To this end, the fuse comprises a relatively rigid casing 13 of preferably cylindrical configuration, the casing having an opening 15 therein, the upper portions 17 of which form an explosion chamber. The upper portions of the casing are closed and the opening 15 extends to and opens at the lower end of the casing, which is threaded as at 19. The lower portions of the opening 15 are slightly larger than the upper portions 17, a shoulder 21, facing the open lower end of the casing, being formed between the upper portions 17 and the lower portions 23.

The lower enlarged portions 23 of the opening 15 are adapted to receive annular washer-like members 25, 27, and 29, each having a central perforation, the members 25, 27, and 29 being arranged in stacked relationship within the enlarged portion 23 with the disk 25 seating at its upper peripheral edges against the shoulder 21, the disks bearing at their peripheries snugly upon the sides of the channel portion 23 and thus being held in place with the perforations of the stacked disks in alignment to form a restricted channel communicating with the upper portion 17 of the opening 15.

The upper surface of the element 25 is provided with a conical depression 31, which faces into the chamber portions 17 when the part is assembled on the shoulder 21. If desired, an enclosing sleeve 33 may be positioned around the parts 27 and 29 within the channel portion 23. A terminal element 35 comprising a disk-like portion 37 and a necked portion 39 is applied to the lower end of the element 29 in position such that the disk-like portion 37 closes the lower end of the channel formed by the aligned openings of the elements 25, 27, and 29. The terminal element 35 is made of suitable conducting material, such as copper, and may be formed as a screw machine product. The disk-like element 25 also comprises a terminal element and is preferably formed of suitable metallic conducting material such as copper, while the disk-like elements 27 and 29 are made of suitable insulating and arc-resisting materials. The casing 13, containing the explosion chamber 17, is also preferably made of a suitable current conducting material of superior strength to resist collapse under the explosive force with which the current-carrying liquid is expelled into the explosion chamber from the restricted bore provided by aligned openings of the elements 25, 27, and 29 when the fuse blows. To this end, the casing 13 is preferably formed of steel and as a screw machine product for the sake of reducing manufacturing costs.

The parts 25, 27, and 29, and the sleeve 33, if used, and also the terminal element 35 are held in alignment and in the channel portion 23 by suitable clamping means comprising, in the embodiment illustrated in Figures 1, 2, and 3, a preferably metallic collar 41 adapted to be threadingly secured on the threaded end 19 of the casing 13 and a holding block 43, preferably of insulating material, having a socket 45 to receive the projecting portions of the sleeve 33 and the arc-resisting element 29. The block 43 is secured to the collar 41 in any suitable fashion as by means of the fastening elements 47, comprising studs threading into openings 49 formed in the collar 41. A shell-like terminal 51, having an annular flange 53, is secured by and between the collar 41 and the block 43, the flange 53 being clamped between said collar and block. The remaining portions of the terminal element 51 extend outwardly of the block and collar to form a substantially cylindrical shell formed with screw threads so that the shell provides means for connecting the device as in an electrical outlet socket.

The block 43 has a central opening 54, through which the necked portion of the terminal element 35 projects and a disk 55 of insulating material is carried on the lower end of the necked portion in position extending to cover and conceal the heads of the clamping stud 47. The insulating disk 55 is held on the terminal element 35 by means of a washer 57 carried by the terminal element 35 outwardly of said disk 55, the end of the terminal element being peened or riveted as at 39 in order to hold the washer 57 and the disk 55 in place. The washer 57 has an ex-

tension 59 adapted to be folded over upon the peened or riveted portions of the terminal element in order to provide a contact for engaging the central contact of an outlet socket in which the fuse 11 is adapted for mounting.

It will be seen from the foregoing that the casing 13, when the parts are assembled, will extend upwardly and centrally of the collar 41, while the shell 51 extends upwardly at the edges of the collar 41 in concentric relationship with respect to the casing 13. In order to finish the fuse, a suitable cover 61, preferably comprising a porcelain element, having a cylindrical portion 63 and a flanged head 65, is assembled in position with the lower end of the cylindrical portion 63 extending between the casing 13 and the shell 51. The cylindrical portion 63 encloses the explosion chamber 13, while the upper portions of the cover 61, including the flange 65, provide means for grasping and manipulating the fuse without danger of contact with the metallic current-carrying portions of the assembly and more particularly the explosion casing 13, which it will be noted is in electrical contact with the terminal 51 through the collar 41.

If desired, the upper end of the cover 61 may be imperforate, although I prefer to form the same with an opening 67, in which a card 69 may be mounted in any suitable or convenient fashion in position with its surface exposed through the opening 67. This card provides a convenient surface on which to print information concerning the fuse, more particularly the current-carrying capacity of the fuse, the manufacturer's name, and the like. The lower end, of the cover 61, may also be provided with depressions for accommodating the threaded ends of the fastening studs 47, should the same project from the upper surface of the collar 41. The cover 61 may be held in place in any suitable or convenient fashion as by crimping the upper edge of the terminal 51 in an annular groove 73 formed in the outer surfaces of the cylindrical portions 63 of the cover. If desired, a suitable insulating cement may also be employed to secure the cover in place.

In Figure 4 of the drawing, I have indicated the desirability of reducing the height of the disk-like element 29 and inserting a washer 28 of suitable heat and electrical conducting material between the elements 27 and 29. This washer 28 has a central perforation adapted to align with the perforations of the washers 27 and 29 so that the washer 28 may define at least a part of the restricted channel which normally contains the liquid current conductor when the fuse is in operating condition. It will be seen from an inspection of Figure 2, that when the column of mercury, or other suitable current-carrying liquid 75 is in the operating position illustrated, that a circuit will be completed between the terminal element 35 and the terminal element 25. Since the terminal element 35 is electrically connected with the contact element 59, while the terminal element 25 is engaged electrically with the contact 51 by virtue of its contact with the casing 13, which in turn is in electrical contact with the collar 41, the collar being electrically connected with the contact 51, it will be seen that the mercury column forms the electrical path between the contacts 51 and 59. Terminals 25 and 35 however are insulated from each other by virtue of the intermediate insulating elements 27 and 29 so that the portions of the column 75 extending in the aligned perforations of the insulating elements 27 and 29 will carry all of the current flowing between the contacts 51 and 59, that is to say, the current in the circuit protected by the device. When the current in the protected circuit becomes excessive, the current density in the mercury column increases sufficiently to vaporize the mercury and cause the same to be expelled from the restricted channel portion into the explosion chamber 17. The mercury being thus removed from between the elements 25 and 35 interrupts the protected circuit at this point. It will be seen that the determining factor is the current density required to vaporize and expel the mercury in the channel portions defined by the insulators 27 and 29. By introducing the element 28 between the insulators 27 and 29, which element 28 is of current carrying material, I am able to reduce the current density in the mercury column at this point. Consequently, a fuse having a current-carrying element 28 may be made to carry a relatively larger current without blowing than a fuse of similar size in which non-conducting elements are used in forming the restricted channel between the terminals 25 and 35. By employing a metallic element 28, the heat generated in the mercury column may also be dissipated more rapidly, since the element 28 operates as a heat transferring element to deliver heat generated by the flow of current through the mercury column through the sleeve 33 to the relatively large metallic mass provided by the collar 41 and the casing 13. The sleeve 33, in such case, electrically insulates the member 28 from the collar and casing, while permitting heat to be transferred relatively freely. The sleeve 33 may be relatively thin since its only function is to electrically insulate the metallic element 28. The potential difference between said metallic element and the casing 13 is not large.

It will be seen, therefore, that, by interposing a metal disk 28 between the insulators 27 and 29, I have provided a fuse adapted to carry a much larger current without blowing and without increasing the size of the device.

In Figure 5, I have shown a modified arrangement wherein the elements 25, 27, and 29, and the element 28, if used, and also the terminal element 35 are received within the lower portions 23 of the casing 13. The parts are clamped in place by a screw-threaded cover 81, which corresponds with the collar 41 of the embodiment illustrated in Figures 1, 2, and 3. The cover 81, however, has a portion 83 bearing through an insulating washer 85 upon the back of the disk-like portion 37 in order to clamp said portion and the perforated elements, forming the restricted channel, in place in the casing 13, so that the casing cover and channel forming elements may be assembled as a unit for insertion in a preferably porcelain casig 91 of generally cylindrical form and carrying a shell-like terminal element 51 on its outer surfaces, the flange 53, of said element engaging a shoulder 93 formed in the casing 91. The bottom, of the casing 91, is preferably closed save for a perforation 95, while the top of the casing is open.

The explosion chamber 13 is provided with an extension 87, on which is riveted one end of a conductor 89. The terminal element 35 has an elongated neck extending through a central perforation 97 formed in the cover 81, said elongated neck carrying a washer 99, which is held in place on the neck by means of an element similar to the element 57 shown in the embodiment of Figures 1, 2, and 3. This terminal element has a por-

tion corresponding with the portion 59 of the element 57 and adapted to extend through the opening 95 in the bottom of the cover 91 when the assembly is positioned in said casing by insertion through the opening at the upper or top end thereof. As the assembly is thus inserted, the conductor 89 may be forced into and through an opening 101 formed in the walls of the casing 91 in position such that the remote end of the conductor 89 extends in contact with the terminal shell 51. The conductor 89 is preferably soldered or otherwise electrically connected on said shell 51 after the parts have been assembled and serves not only to connect the shell 51 with the casing 13 but also to retain the shell on the housing 91 with the flange 53 snugly bearing against the shoulder 93. After the parts are assembled, the terminal plate extending through the opening 95 may be bent down flat against the lower surface of the housing 91 in position to engage a terminal of an outlet socket in which the fuse is adapted to be mounted for use, the other or screw-threaded terminal of the outlet socket receiving the threaded contact-shell 51. The device may be finished by applying a disk-like cover 103 of insulating material in position to close the open top of the housing 91 and to retain the explosion casing in place. If desired, means may be provided between the upper ends of the explosion chamber and the housing 91 to maintain the casing 13 in alignment within the housing.

It will be apparent from the foregoing that the essential features of the fuse as shown in Figure 5, are identical with those of the fuse shown in Figures 1, 2, and 3 as far as the functional characters of the devices are concerned. The arrangement in Figure 5, however, permits the explosion chamber and cover, including the perforated channel forming disk to be assembled as a unit and loaded with the current carrying liquid ready for insertion in the housing 91 and also provides for the complete enclosure of all of the perforated elements entirely within the casing 13. The forms shown in Figures 1, 2, and 3, however, has the advantage of minimum manufacturing parts through the arrangment of the parts and provides a substantial mounting for the contact 51 by clamping the same between the collar 41 and the plate 43.

The invention provides an inexpensive fuse construction whereby the fuse, after blowing, may be reconditioned for service by simply shaking the device in order to return the liquid into the relatively restricted channel provided by the perforations in the members 27, 28, and 29. After being returned to operative position, the inherent surface tension of the liquid and its ability to cling to the conically depressed surfaces 31, as shown clearly in Figure 2 of the drawing, will ordinary prevent the liquid from draining into the explosion chamber 17. The perforation in the element 25 may be relieved as at 105 in order to assist in retaining the mercury in the channel.

It is thought that the invention and numerous of its attendant advantages will be understood from the foregoing description and it is obvious that numerous changes may be made in the form, construction, and arrangement of the several parts without departing from the spirit or scope of my invention or sacrificing any of its attendant advantages, the forms herein described being selected embodiments for the purpose of illustrating my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. A circuit breaker of the character described, comprising a metallic casing defining an explosion chamber, a perforated element comprising an electrode in and electrically connected with said casing, means in and insulated from said casing forming a restricted channel communicating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing and clamping means for securing the perforated electrode, the channel-forming means and said terminal in operative position on and in said casing.

2. A circuit breaker of the character described, comprising a metallic casing defining an explosion chamber, a perforated element forming an electrode in and electrically connected with said casing, means in and insulated from said casing and forming a restricted channel communicating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing, clamping means for securing the perforated electrode, the channel forming means and said terminal in operative position on and in said casing, said terminal having a necked portion projecting outwardly of said casing, and a contact element on said terminal.

3. A circuit breaker of the character described, comprising a metallic casing defining an explosion chamber, a perforated element forming an electrode in and electrically connected with said casing, means in and insulated from said casing and forming a restricted channel communicating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing, clamping means for securing the perforated electrode, the channel forming means and said terminal in operative position on and in said casing, said terminal having a necked portion projecting outwardly of said casing, a contact element on said terminal, and means insulating said terminal and contact member from said casing.

4. A circuit breaker as set forth in claim 1, a protective housing secured to and enclosing said casing, a contact element on said housing adapted for connection in an external circuit to be protected, and means electrically connecting said contact member with said casing within the housing.

5. A circuit breaker of the character described, comprising a metallic casing defining an explosion chamber, a perforated element forming an electrode in and electrically connected with said casing, means in and insulated from said casing and forming a restricted channel communicating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing, clamping means for securing the perforated electrode, the channel forming means and said terminal in operative position on and in said casing, a protective housing enclosing said casing, a contact element on said housing, means electrically connecting said contact member with said casing, and a second contact member exposed outwardly of said housing and electrically connected with said terminal.

6. A circuit breaker of the character described comprising a metallic casing defining an explosion chamber, a perforated element comprising an electrode in and electrically connected with said casing, means in and insulated from said casing forming a restricted channel com-

municating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing, clamping means for securing the perforated electrode, the channel-forming means, and said terminal in operative position on and in said casing, a protective housing enclosing said casing, a contact element providing screw threads exposed on said housing, means electrically connecting said contact member with said casing, and a second contact member exposed in an axial position on said housing and electrically connected with said terminal.

7. A circuit breaker of the character described comprising a metallic casing defining an explosion chamber, a perforated element comprising an electrode in and electrically connected with said casing, means in and insulated from said casing forming a restricted channel communicating with said chamber through the perforation of said electrode, a terminal exposed in said restricted channel and insulated from said casing, clamping means for securing the perforated electrode, the channel-forming means, and said terminal in operative position on and in said casing, said terminal having a necked portion projecting outwardly of said casing, a contact element on said terminal disposed axially of said casing, an annular contact formed with screw threads encircling said casing in concentric relationship therewith, means electrically connecting said annular contact with said casing, and a housing for said casing held in place by said annular contact.

8. A circuit breaker of the character described comprising a cylindrical casing closed at one end, said casing being formed internally with a seat facing away and spaced from said closed end, a perforated element comprising an electrode on said seat in said casing, said element having electrical contact with the walls of said casing, means in and insulated from said casing and forming a restricted channel communicating with the perforation of said electrode, said restricted channel extending from said perforated electrode within said casing toward the open end thereof, a terminal exposed in and closing said restricted channel substantially at the open end of said casing, and clamping means for securing the perforated electrode, the channel-forming means and said terminal in operative position on and in said casing, said clamping means serving to hold the perforated electrode snugly on said seat whereby to define an explosion chamber between said perforated electrode and the closed end of the casing.

WILLIAM C. CRIMMINS.